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RED ALGAL PARASITES OCCURRING ON MEMBERS OF THE GELIDIALES

Kung-Chu Fan and George F. Papenfuss[1]

Three genera and four species of red algae have been reported as parasitic on the various members of the Gelidiales. They are *Syringocolax macroblepharis* Reinsch (1875; Martin and Pocock, 1953), *Gelidiocolax microsphaerica* Gardner (1927), *Choreocolax suhriae* Martin et Pocock (1953), and *C. margaritoides* Martin et Pocock (1953). These species are reviewed and two parasitic red algae occurring on *Pterocladia,* also a member of the Gelidiales, collected by Setchell in New Zealand in 1904 and by Papenfuss in New Zealand in 1949 and in Hawaii in 1942, are described as new.

Gelidiocolax microsphaerica was obtained in 1911 by Gardner on *Gelidium pulchrum* growing at Balboa Beach, Orange County, California. Dangeard in 1952 reported *Gelidiocolax microsphaerica* (in error as *G. hemisphaerica*) from Dakar. Subsequently, the species was reported by Dawson (1952, 1953) from the shores of Isla San Martín, Baja California. Careful examination of specimens of *Gelidium pulchrum* (collected at Punta Descanso, Baja California, Mexico, *Dawson 131–45,* April 8, 1945, UC 694021) has resulted in the finding of additional specimens of *Gelidiocolax microsphaerica*. The tubercle produced by this species is spherical in form, about 175–225μ in diameter, and difficult to detect without the aid of a handlens; it is mostly composed of the reproductive tissue of the parasite. The carpogonial branch is composed of two cells, the spermatangia are produced in chains, and the tetrasporangium is cruciately divided. Although currently placed in the Gelidiaceae (cf. J. & G. Feldman 1958), it appears more likely that *Gelidiocolax* belongs in the Choreocolacaceae.

Choreocolax suhriae is parasitic on *Suhria vittata* in South Africa; the wart-like swelling is composed of a dense mixture of parasite and host tissues; it is about 2–3 mm. broad and about 1 mm. high when mature. During maturation, many or sometimes most of the surface cells of the parasite produce reproductive organs. Its carpogonial branch is two-celled like that of *Gelidiocolax microsphaerica* and not four-celled as in *Choreocolax polysiphoniae,* which is the type species of *Choreocolax* (Sturch 1926). In fact *C. suhriae* resembles *G. microsphaerica* so much that it should be placed in *Gelidiocolax* instead of in *Choreocolax*. The following combination is therefore proposed: **Gelidiocolax suhriae** (Martin et Pocock) Fan et Papenfuss, comb. nov. (*Choreocolax suhriae* Martin et Pocock 1953, p. 48).

Choreocolax margaritoides is parasitic on *Beckerella pinnatifida* in

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[1] This study was aided by a grant-in-aid from the National Science Foundation to the second author. Dr. Mary A. Pocock kindly furnished the material of *Choreocolax suhriae* and *C. margaritoides*.

Madroño, Vol. 15, No. 2, pp. 33–64, May 15, 1959.

South Africa. Tetrasporic specimens of this species were examined. The pustule is roundish, 200–290μ in diameter, and is mostly composed of parasite tissue. This species is closely related to *Gelidiocolax microsphaerica*. However, the tetrasporic pustule is slightly larger than that of *G. microsphaerica,* which is 175–225μ in diameter. The tetraspores of *C. margaritoides* are 12–18μ in length; those of *G. microsphaerica* are 22–28μ in length. In our opinion *C. margaritoides* is a species of *Gelidiocolax*. The following combination is therefore proposed: **Gelidiocolax margaritoides** (Martin et Pocock) Fan et Papenfuss, comb. nov. (*Choreocolax margaritoides* Martin et Pocock 1953, p. 50).

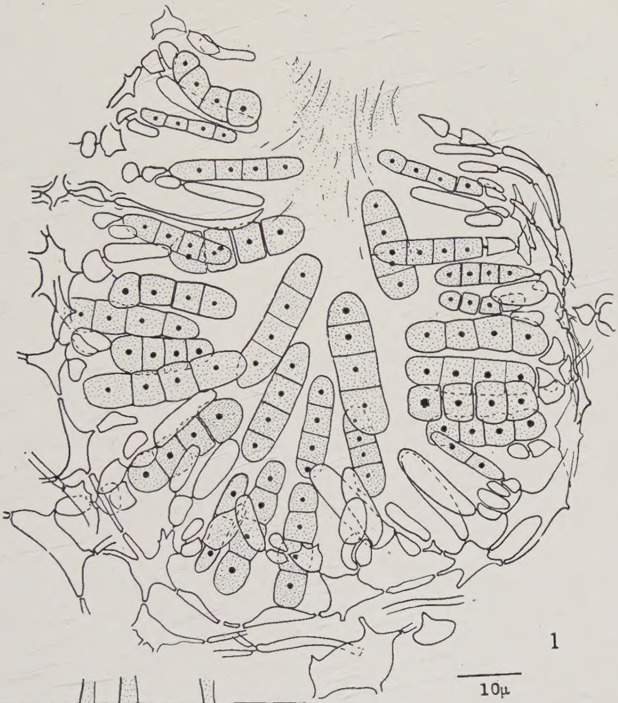
Gelidiocolax mammillata Fan et Papenfuss sp. nov. Planta in *Pterocladia* sp. parasitica, constans e filamentis multis irregulariter ramosis, in telam hospitis profunde penetrantibus, tuberculum solidum verruciforme efficientibus; tuberculum maturum 0.3–1 mm. lat., 0.3–0.5 mm. alt., e tela et hospitis et parasitici compositum, proiectiones mammillatas multas in superficie habens; cystocarpi, spermatangia, tetrasporangiaque in proiectionibus mammillatis praecipue producta, et in cubiculis per telas hospitis effectis reperta; ramus carpogonialis bicellularis; spermatangia in catenis formata, per septa transversa ab extremitatibus terminalibus cellularum-matrum spermatangialium successive abscissa; tetrasporangia cruciate divisa.

Plant parasitic on *Pterocladia* sp., consisting of many irregularly branched filaments which penetrate deeply into the host tissue, producing a wart-like solid tubercle; tubercle when mature 0.3–1 mm. wide and 0.3–0.5 mm. high, composed of both host and parasite tissues, with many mammillate projections on the surface; cystocarps, spermatangia and tetrasporangia produced primarily in the mammillate projections and occurring in chambers produced by host tissue; carpogonial branch two-celled; spermatangia formed in chains, successively cut off by transverse septa from the terminal ends of the spermatangial mother cells; tetrasporangia cruciately divided.

Type. Hanauma Bay, Oahu, Hawaiian Islands, March 1, 1942. *G. F. Papenfuss* (UC 1058497). Figs. 3, 6, 7, 9, 10.

Pterocladiophila hemisphaerica Fan et Papenfuss gen. et sp. nov. Planta in *Pterocladia lucida* parasitica, constans e filamentis multis irregulariter ramosis in telam hospitis profunde penetrantibus, tuberculum solidum plus minusve hemisphericum efficientibus; tuberculum maturum 0.4–1 mm. lat., 0.4–0.8 mm. alt. e telis et hospitis et parasitici compositum, in superficie inaequale; cystocarpi, spermatangia, tetrasporangiaque in concepticulis formata; ramus carpogonialis bicellularis; spermatangia in catenis producta, per septa transvera ab extremitatibus terminalibus cellularum-matrum spermatangialium successive abscissa; tetrasporangia zonate divisa, pavimento lateribusque conceptaculi introrsus obducentia.

Plant parasitic on *Pterocladia lucida,* consisting of many irregularly branched filaments which penetrate deeply into the host tissue, producing



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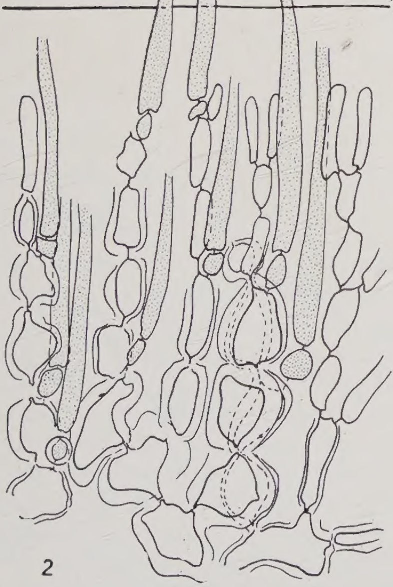

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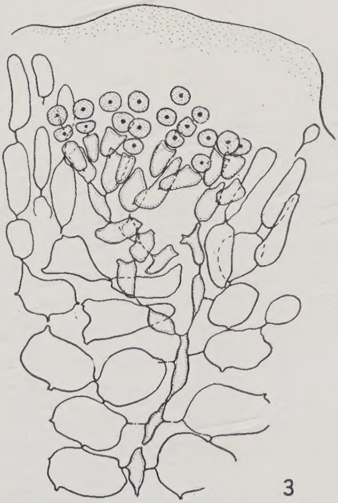

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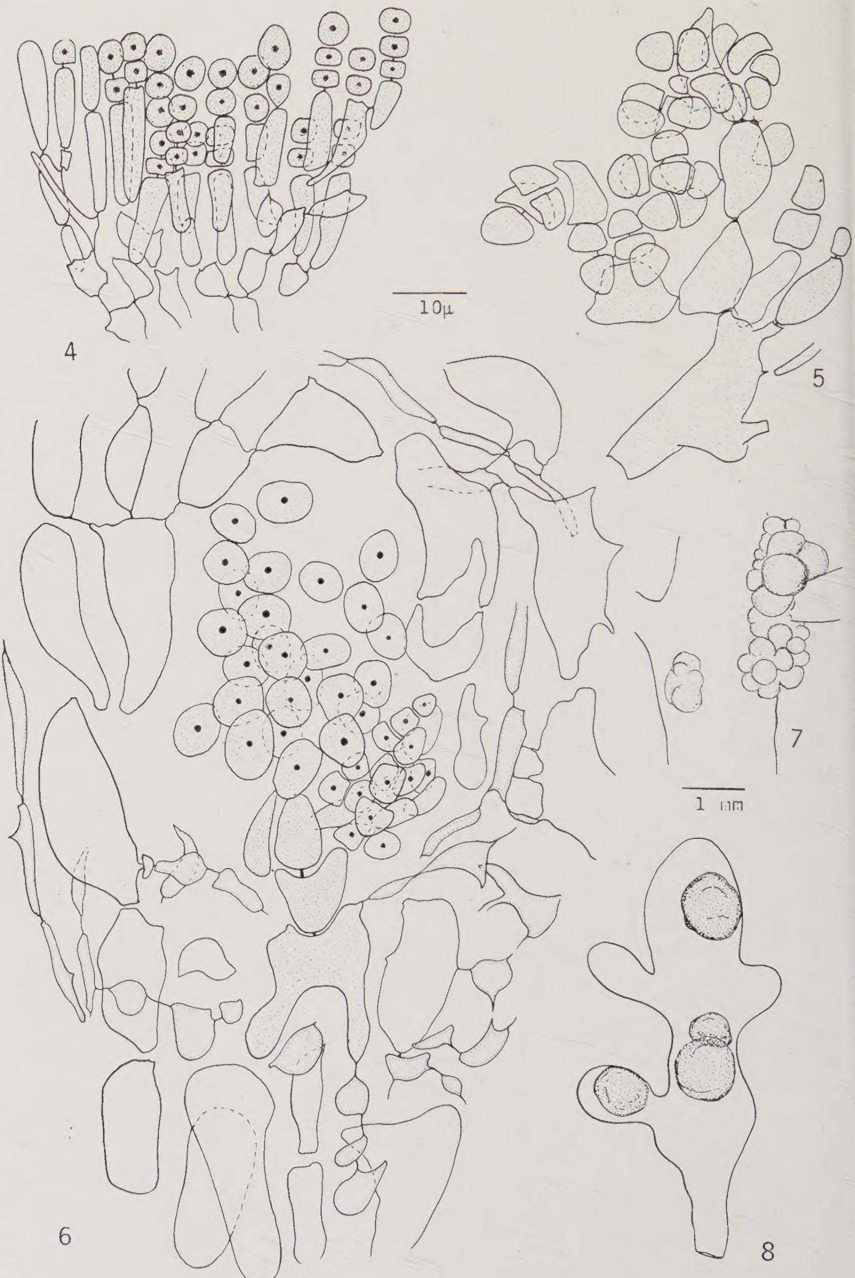
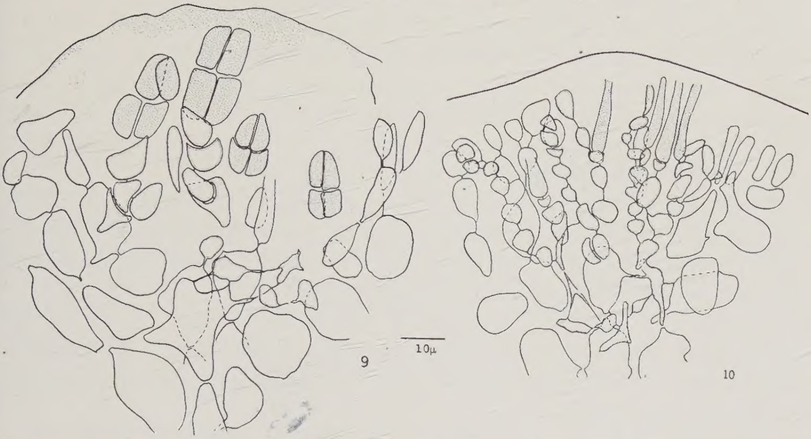
FIGS. 1, 2. *Pterocladiophila hemisphaerica*: 1, tetrasporangia within the conceptacle; 2, carpogonial branches. FIG. 3. *Gelidiocolax mammillata* (marginal stippling) with spermatangia (solid stippling).



FIGS. 4, 5, 8. *Pterocladiophila hemisphaerica*: 4, spermatangia; 5, part of gonimoblast and carposporangia; 8, habit of parasite on *Pterocladia lucida*. FIGS. 6, 7. *Gelidiocolax mammillata* (stippled cells): 6, gonimoblast with carposporangia; 7, habit of parasite on *Pterocladia* sp.



FIGS. 9, 10. *Gelidiocolax mammillata* (marginal and solid stippling); 9, tetrasporangia; 10, carpogonial branches.

a more or less hemispherical solid tubercle; tubercle when mature 0.4–1 mm. wide and 0.4–0.8 mm. high, composed of both host and parasite tissues, uneven on surface; cystocarps, spermatangia and tetrasporangia formed in conceptacles; carpogonial branch two-celled; spermatangia produced in chains, successively cut off by transverse septa from the terminal ends of the spermatangial mother cells; tetrasporangia zonately divided, lining floor and sides of the conceptacle.

Type. Island Bay near Wellington, New Zealand, June 1904. *W. A. Setchell 6098* (UC 1141475) [separated from host plant, *Pterocladia lucida* (UC 95977)]. Figs. 1, 2, 4, 5, 8.

Additional material. New Zealand: Kaikoura, 17 February 1949, *Moore* and *Papenfuss* (UC 1058496); Goose Bay 10 miles south of Kaikoura, 18 February 1949, *Moore* and *Papenfuss* (UC 1058495).

Pterocladiophila is readily distinguished by its zonately divided tetrasporangia (fig. 1), formed within conceptacles, from all the known genera of parasitic red algae except *Chaetolithon* Foslie (1898; Kylin 1956), *Choreonema* Schmitz (1889; Suneson 1937), and *Polyporolithon* Mason (1953) in which three genera the sporangia are also zonately divided and localized in conceptacles. *Chaetolithon, Choreonema* and *Polyporolithon* belong to the family Corallinaceae, which family is almost exclusively composed of calcareous algae. Also, as far as known, the spermatangia are not produced in chains in the Corallinaceae as they are in *Pterocladiophila.*

Pterocladiophila cannot be assigned to the Choreocolacaceae owing to its zonately divided tetrasporangia which are formed in deeply sunken conceptacles (fig. 1). Nor can it be assigned to the Corallinaceae (although it resembles some members of this family by its simple, two-celled carpogonial branch and its zonately-divided tetrasporangia produced in conceptacles) because it is not calcified as all the Corallinaceae are with the exception of *Schmitziella* (Batters 1892, Suneson 1944); it also differs from members of this family in having the spermatangia produced in chains (fig. 4). A new family *Pterocladiophilaceae* is therefore suggested here, and this family is tentatively assigned to the order Cryptonemiales. This family is characterized by the following features.

Pterocladiophilaceae Fan et Papenfuss fam. nov. Thallus haud calcifactus ramo carpogonio bicellulato spermatangia catenulata septis transversis termino cellulae maternae spermatangialis enata tetrasporangia zonatim divisa in conceptaculis circumscripta.

Thallus not calcified; carpogonial branch two-celled; spermatangia produced in chains, succesively cut off by transverse septa at the terminal end of the spermatangial mother cell; tetrasporangia zonately divided, formed in conceptacles.

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XEROPHYLLUM TENAX, SQUAWGRASS, ITS GEOGRAPHIC DISTRIBUTION AND ITS BEHAVIOUR ON MOUNT RAINIER, WASHINGTON[1]

Sue Merrick Maule[2]

The objectives of the present study of *Xerophyllum tenax* are twofold; to compile information regarding its geographic distribution and to study the specific environmental requirements necessary for its vegetative growth and blossoming on Mount Rainier, Washington. Since the field observations have been confined to a single season, the results presented must be considered as tentative. In order to study the environmental requirements fully, stations with permanent protected plots would have to be established throughout the range of the species and observations made over a period of years.

Xerophyllum tenax (Pursh) Nutt. (fig. 1) is a tufted, herbaceous, graminoid, perennial hemicryptophyte having a tuber-like woody rootstock bearing cord-like roots. It bears numerous grass-like, keeled, rigid leaves 5–10 dm. long, 5–10 mm. wide at the base and gradually tapering to a narrow, stiff and wiry tip, the margins rigid and serrulate (Peck, 1941; Jepson, 1951). According to Dr. D. B. Lawrence (personal communication), the young seedlings can be distinguished from those of *Carex* species by a grey-white bloom which covers the leaves of the *Xerophyllum*. Flowering occurs between May and September. The inflorescence stalks, 3–15 dm. high, are covered by leaf-like bracts which are reduced toward the top, and the raceme, 1–2 dm. long, is very dense, with slender pedicels 2–5 cm. long. The perianth is cream-colored, with lanceolate segments 6–10 mm. long, the stamens surpass the perianth, and the capsule is broadly ovoid, acute, 5–7 mm. long.

Xerophyllum tenax is found from west-central California northward to northwestern Washington, and from Yellowstone National Park northwestward to southwestern Alberta and southeastern British Columbia. Along the coast, at least in northwestern Washington where habitat conditions are specifically recorded, it is found at sea level on bogs, and in the rain-shadow of the Olympic Mountains on gravelly "prairies" (Jones, 1936). It occurs again high in the coast ranges, and from approximately 2000 feet to 7000 feet in the Sierra-Cascade and Rocky Mountain ranges. Thus it is widely separated geographically from the eastern North American species, *X. asphodeloides* (L.) Nutt., which grows at low altitudes on sandy acid pineland of the Atlantic Coastal Plain from North Carolina

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[1] Requests for reprints should be addressed to Prof. D. B. Lawrence, Department of Botany, University of Minnesota, Minneapolis 14.

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[2] Sincere thanks to the following, without whose help this contribution would not have been possible: Robert William Maule, for his indispensable work in the field; Dr. Donald B. Lawrence, for help in planning and in organization of results; Dr. Gerald Ownbey, for help with taxonomic problems.

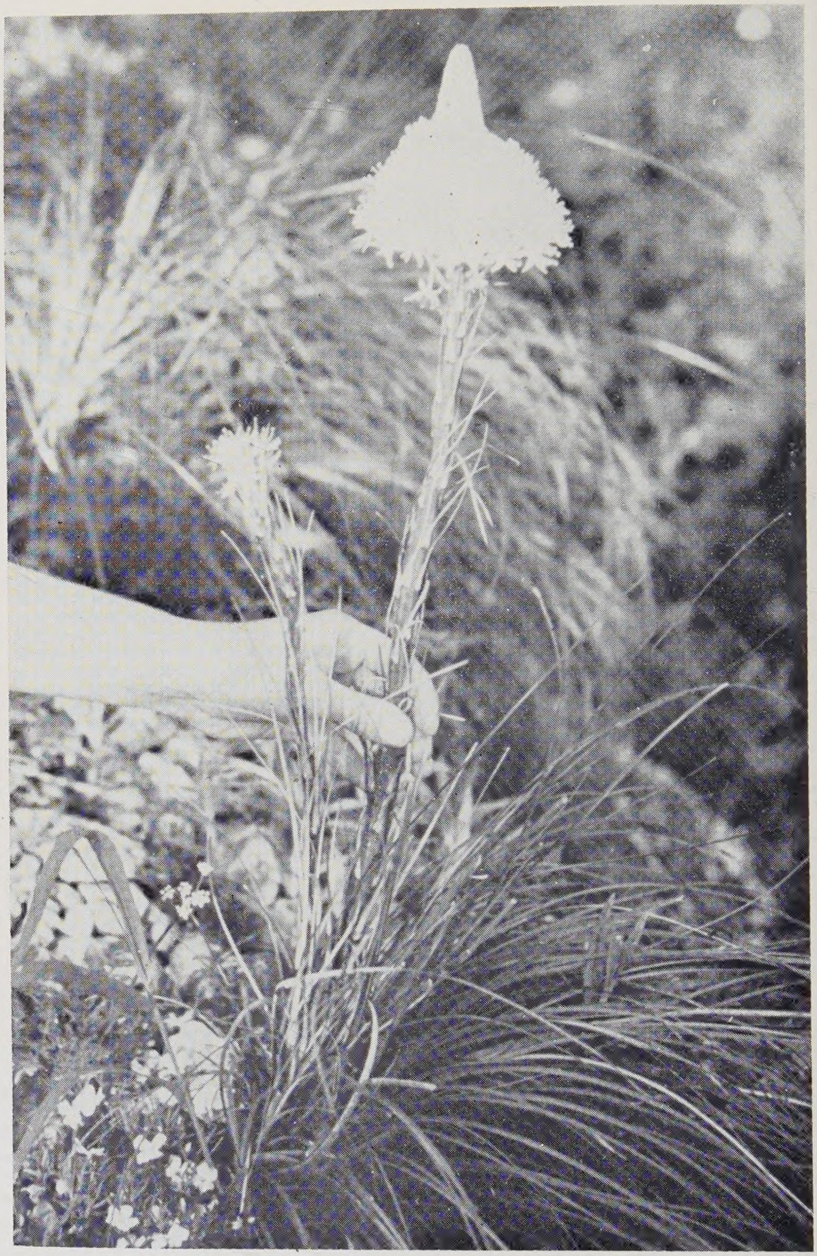


FIG. 1. *Xerophyllum tenax* with an abnormal stunted inflorescence, beside trail, Station 2, Mount Rainier. Normal inflorescence from another plant held in hand.

to New Jersey, and again in the Blue Ridge Mountains and Appalachian Plateau in acid woods of Georgia, North Carolina, Tennessee, and Virginia (Fernald, 1950; Small, 1933).

The geographic distribution of *Xerophyllum tenax* is shown in a map (fig. 2), data for which was compiled from information supplied by staff members of various herbaria (Univ. Calif., Univ. Idaho, Univ. Oreg., Oreg. St. Coll., Univ. Wash., Wash. St. Coll., Nat. Mus. Canada, Univ. Alberta, Univ. Brit. Col.). The species occurs very sparingly in the coastal region near sea level from west-central California to northwestern Washington, and again just below the summits of the coast mountains over almost the same latitudinal range. In the Sierra-Cascade range, it is found from Placer County, California, northward 700 miles to Stampede Pass, Washington, ranging in altitude from approximately 2000 to 6000 feet. It is not known to occur on Mount Shasta. In the Rocky Mountains complex it occurs from 2000 to 7000 feet, with the southernmost limit of its range along the southern boundary of Yellowstone National Park, whence it extends northwestward about 450 miles to Crow's Nest Pass on the British Columbia-Alberta boundary. Westward it extends from the Rocky Mountain divide approximately 200 miles to northern Idaho, reaching its western limit on the summit of Mount Spokane, Washington, at 5800 feet. In Idaho it ranges from southern Lemhi and Valley counties northward to the International Boundary and on in British Columbia to Kootenay Lake, a northwestward extent of 380 miles.

Judging from the differences in habitat that have been reported in the literature, and the broadness of the geographic distribution pattern, it would be reasonable to expect that several races exist within the species. There appear to be definite distributional gaps between the plants growing at sea level along the immediate coastal strip and those growing high in the coast range; similarly a distributional gap exists between the coast ranges and Sierra-Cascades, and another large one between the latter and the Rocky Mountains complex. Although the distribution map (fig. 2) would suggest continuity within the groups running north and south, it is quite possible that the plants growing in the north belong to quite different races from those growing in the outposts along the California coast, the southern Sierras, and the Rocky Mountains in northern Wyoming. It would be very interesting to take individuals from widely different geographical areas and grow them adjacent to each other in experimental plots at several places within the distribution range. Dissimilarities would almost certainly be found.

XEROPHYLLUM TENAX ON MOUNT RAINIER

Between July 13 and August 23, 1955, field work was carried on at Mount Rainier National Park, Washington, and thirty-four stations were established where the species was studied. Figure 3 and Table 1 present the data for these stations and show through description and symbol those characteristics of the plants and of their local environments which were

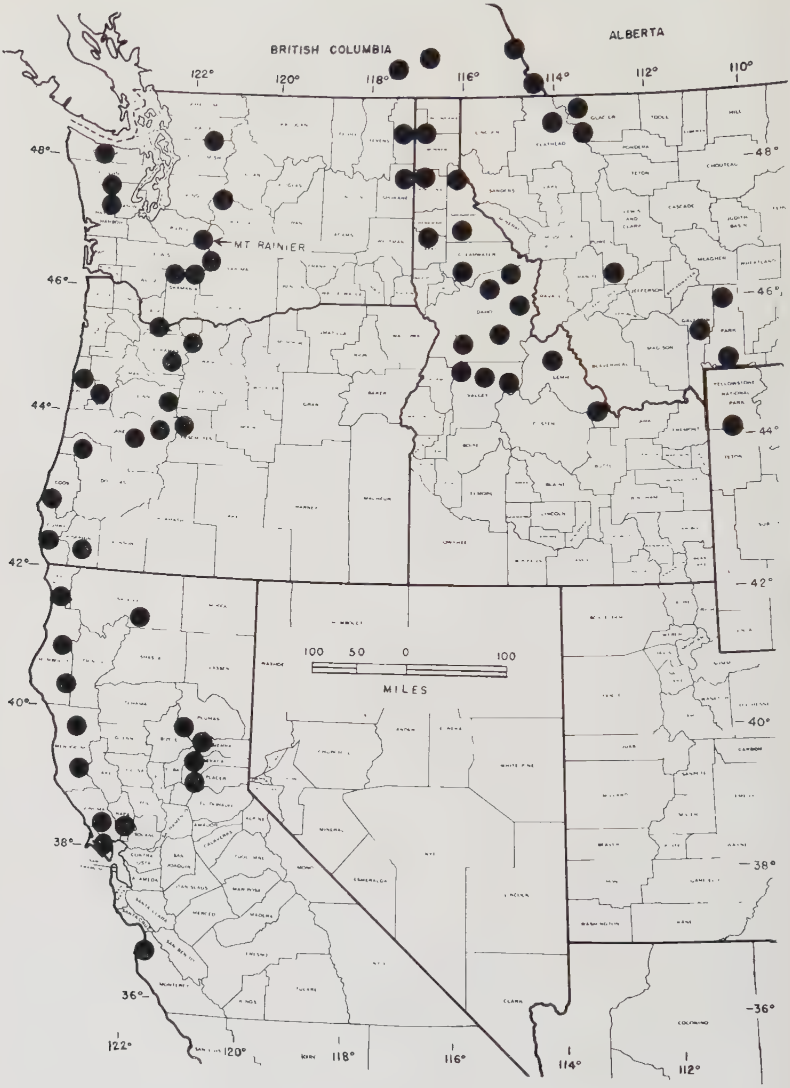


FIG. 2. Distribution map of *Xerophyllum tenax*.

considered significant in determining causes of local distribution. At thirty-three field stations detailed data were recorded as follows: date, time of day, location, elevation, degree and direction of slope, density of spacing measured as minimum distance between *Xerophyllum* clumps, presence of new or old flower stalks, composition of the adjacent vegetation, and history of fire. Where flowering was in progress the following were also recorded: root temperatures in degrees centigrade of flowering and of non-flowering plants three inches below ground surface, height in centimeters of the flower stalk up to base of the raceme, and diameter of flowering stalk in millimeters measured just above basal leaves.

From the data accumulated at these field stations, it appears that the distribution of *X. tenax* within Mount Rainier National Park seems to be influenced by a number of factors, including soil temperature, elevation, and direction and angle of slope.

There are some factors, for example soil water content, which seem to have no apparent influence on its distribution. Individuals were found thriving equally well on dry sunny hillsides and on moisture saturated soil immediately below rapidly disappearing snow banks. This latter observation seems related to the occurrence of *X. tenax* on bogs near sea level. The amount of shading by an overstory also does not seem to be a limiting factor for vegetative growth. Although all the plants found blooming in 1955 were growing in open meadows, light woods, or shrubby areas, and not in dense forests, the ability of the adult plants to survive did not seem to be affected by the amount of shading they received. Plants were found growing well vegetatively in dense forests where little or no direct sunlight filtered through the canopy and also on slopes exposed to the sun for as long as twelve hours a day.

Most of the stations were visited between 10 A.M. and 3:30 P.M. on days of roughly equivalent fair meteorological conditions over a period of about forty days between July 13 and August 25. Recorded air temperatures ranged from 13°C. to 30°C., and soil temperatures three inches below the surface beneath the leaf crowns of *X. tenax* ranged from 9°–18°C.

Within the Park, only the upper limit of distribution could be ascertained, as plants were found growing at the lowest easily accessible boundaries of the Park at 2000 feet and also somewhat lower outside. Although most of the plants were found below 6000 feet, one group of plants was found near Panhandle Gap, Station 22, at 6800 feet. This elevation was the upper limit of all vascular plant growth here, with only lichens and mosses occurring higher. Within this area there were numerous perennial snow fields.

The chief factor that did appear to affect the distribution was direction of slope, and this in turn influences length of snow-free growing season and soil temperature. *Xerophyllum tenax* was found growing on south-facing slopes, one as steep as 55 degrees, at ten stations, on southeast slopes at seven, on southwest slopes at four, on west slopes at three, on east slopes at two, and on north slopes at only one station. In this last

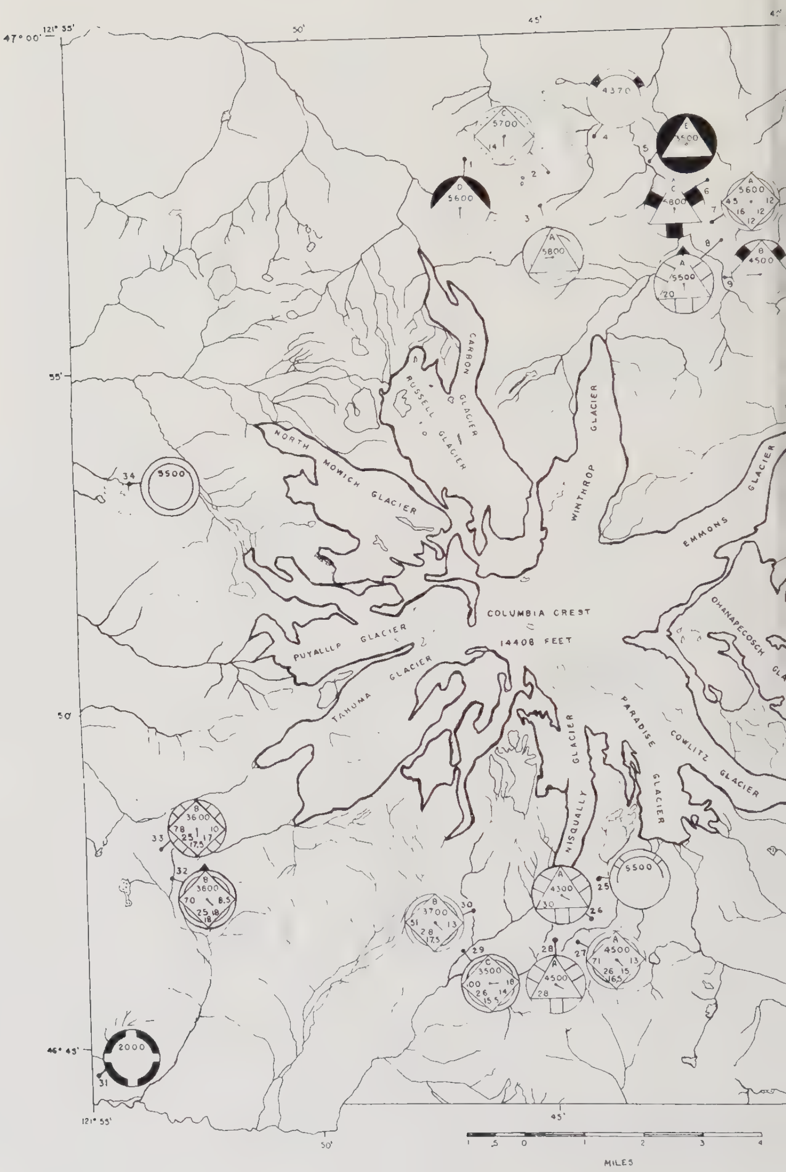
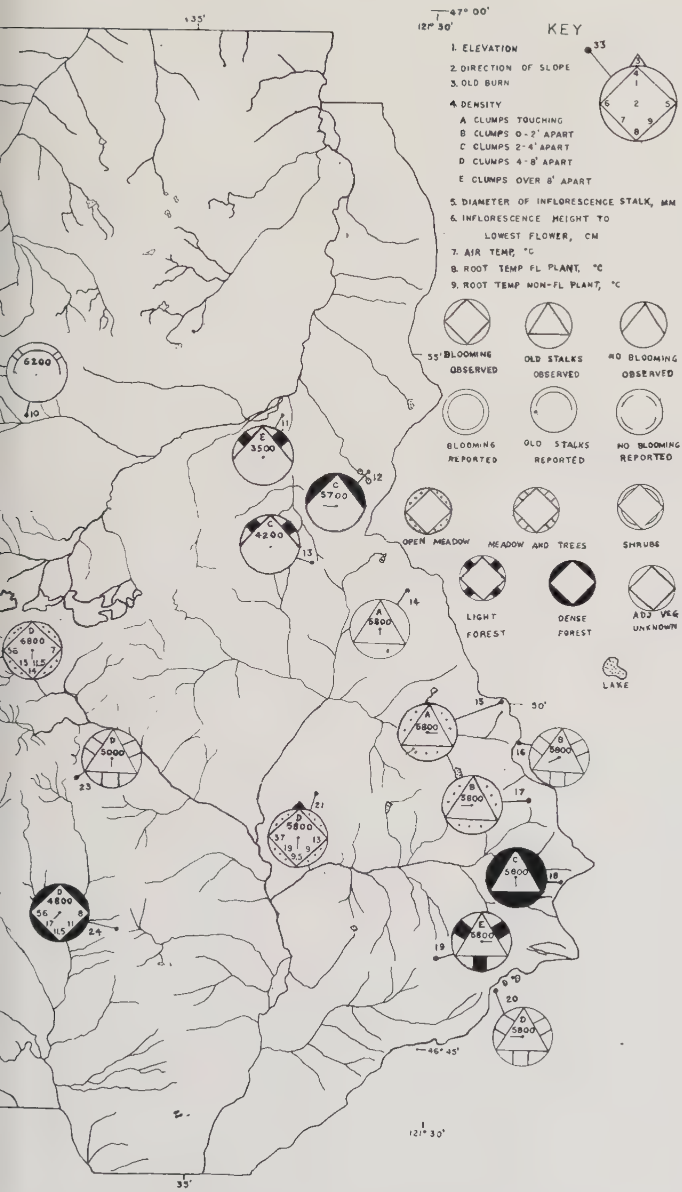


FIG. 3. Map of Mount Rainier National Park showing distribution of *Xerophyllum tenax* (based on observations and reports in 1955). The stations, numbered clockwise beginning in the northwest, are represented by circles connected to black dots (the actual sites).



One or more study sites was established at each station. Traced from USCG topographic map, Mount Rainier National Park, Washington, 1954.

Table 1. Descriptions of Field Stations Where Study Plots of Xerophyllum tenax were Established on Mount Rainier in 1955

Station No.	Date	Time	Slope	Location, Snow and Soil Conditions
1	Aug. 2	3:30 p.m.	15° south	1 mile west Yellowstone Cliffs, North Loop trail; soil wet.
2	Aug. 2	3:15 p.m.	45° south	Yellowstone cliffs, North Loop trail.
3	Aug. 2	2:45 p.m.	10° west	Windy Gap, North Loop trail; large snow fields adjacent.
4	Aug. 2	11:30 a.m.		Lake James, North Loop trail; snow areas present.
5	(See Fig. 3)			
6	Aug. 1	3:45 p.m.	15° south and also gentle north	West slope Grand Park, North Loop trail; numerous snow fields nearby.
7	July 25	12:15 p.m.	10° south	South edge of Grand Park, North Loop trail; no snow.
8	July 25	12:00 m.	18° south	South edge of Grand Park, North Loop trail; snow fields present.
9	July 25	11:00 a.m.	25° west	1 mile north Berkeley Park shelter, North Loop trail; snow fields present.
10	July 25		18° east	Yakima Park.
11	Aug. 25	12:00 m.		White River Entrance Station.
12	Aug. 22	2:20 p.m.	south	Deadwood Lakes; very wet.
13	Aug. 22		south	Ghost Lake.
14	Aug. 23	9:00 a.m.	5° south	Cascade Crest trail.
15	Aug. 23	10:45 a.m.	45° east	"
16	Aug. 23	12:30 p.m.	southwest	"
17	Aug. 23	1:00 p.m.	40° west	"
18	Aug. 23	2:15 p.m.	south	"
19	Aug. 23	4:30 p.m.	west	Three Lakes-Ohanapecosh trail.
20	Aug. 23	2:45 p.m.	40° west	Cascade Crest trail.
21	Aug. 5	12:00 m.	5° south	Shriner's Peak Lookout.
22	Aug. 17	10:45 a.m.	18° south	0.5 mile south Panhandle gap, Wonderland trail; highest elevation at which flowering plants were found.
23	Aug. 16	2:45 p.m.	10° south	Cowlitz Divide, 1 mile south Indian Bar, Wonderland trail.
24	Aug. 16	10:15 a.m.	15° west	2 miles east Nickel Creek patrol cabin, Cowlitz Divide, Wonderland trail.
25	Aug. 25		south	Paradise Valley.

Station No.	Date	Time	Slope	Location, Snow and Soil Conditions
26	July 13	10:35 a.m.	12° southeast	0.1 mile below Canyon Rim; snow present; dry soil.
27	July 13	10:15 a.m.	30° south	Narada Falls.
28	July 12	10:30 a.m.	13° south	0.7 mile below Narada Falls; melting snow fields nearby, soil wet.
29	July 13	10:40 a.m.	12° east	1 mile below Christine Falls; soil dry.
30	July 13	10:50 a.m.	38° south	Christine Falls; only a few plants in bloom, all against rock cliff.
31	Aug. 31			Nisqually entrance.
32	July 17	3:30 p.m.	38° south	2 miles south of Round Pass, West Side road.
33	July 17	3:40 p.m.	55° south	2 miles south Round Pass, West Side road.
34	Aug. 17			Golden Lakes.

instance the surface was nearly level, and the plants had evidently spread over the crest of a small hill from a south-facing slope; they indicated no sign of present or past flowering.

It has been noted in former years by Mount Rainier Park rangers that *X. tenax* increases greatly in numbers two to three years after a forest fire. Several competent observers related having seen it growing densely in old burns; these observations agree with those of the present writer.

A few factors that seemed to have relatively little effect on distribution definitely did appear to inhibit flowering. The one most obviously important in bringing about flowering during the 1955 season was the amount of light reaching the plant. Although old flowering stalks were found in dense forest as well as in open meadows in 1955, no plants were observed to bloom in dense shade. Instead, all flowering plants were confined to open meadows, light forests, or shrub-covered areas. Other limiting factors controlling flowering are probably temperature, especially of the soil, and, as will be evident later, the length and warmth of the growing season the previous year when the flower buds were being formed.

Soil temperatures about the roots at a three-inch depth beneath the clumps of flowering plants were between 0.5°–2.5°C. higher than those beneath non-flowering plants in the same vicinity. At only two stations were the root temperatures of flowering and non-flowering plants the same, and in no case was root temperature of the non-flowering plant found higher than the flowering one. Great care was taken to insure that the two plants studied at each station were on terrain of approximately the same amount of moisture, sunlight, etc. Perhaps the differences in recorded soil temperatures were due to slight differences in topography, humus content of the soil, and qualitative and quantitative differences in the ground cover.

At most stations, no plants were seen flowering in 1955, although most plants retained old flowering stalks. At no time or place during the entire season were great displays of blossoms found, as had been reported in previous years. At the few stations where blossoms were present, only a few plants were involved and incidence of flowering did not seem especially related to density of spacing of clumps. Jepson (1901) has suggested that *X. tenax* blooms only once every seven years on Mount Tamalpais, Marin County, California. It is not likely that a similar flowering cycle exists on Mount Rainier. The 1955 season seemed to be the only season in several years in which *X. tenax* had not flowered heavily.

Inasmuch as flower-stalk elongation in this species begins in early summer, the 1955 flowering stalks were quite surely initiated during the 1954 growing season. Dr. A. W. Harrison of the University of Washington has observed the weather conditions on Mount Rainier for several summers. He reported (personal communication) that the summer of 1954 was one of the "poorest" during the last ten years, and that the last ten years have been below average in temperature, rainfall, and sunny days. In 1954 the snow disappeared at an elevation of 4500 feet on the south side of Mount Rainier one week later than in 1953 and four weeks later than in 1952. Probably the effectiveness of the growing season for *Xerophyllum* in 1954 was reduced by cooler temperature during the summer, as well as by the later start due to the persistence of the snow cover. It is quite probable that the length of the 1954 growing season was not long enough or warm enough to initiate many flower buds.

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DOCUMENTED CHROMOSOME NUMBERS OF PLANTS

(See Madroño 9:257–258. 1948.)

Species	Number	Counted by	Collection	Locality
LILIACEAE				
**Hesperocallis undulata* A. Gray	2n=24 II	H. Lewis, LA[1]	*Lewis* in 1952, LA	Borrego Valley, San Diego County, California
**Nolina parryi* S. Watson	2n=20 II	H. Lewis, LA	*O'Donnell* in 1953, LA	Piñon Flats, Riverside County, California
**Zigadenus brevibracteatus* H. M. Hall	2n=11 II	H. Lewis, LA	*Lewis* in 1950, LA	Red Rock Canyon, Kern County, California
RANUNCULACEAE				
**Ranunculus occidentalis* var. *eisenii* A. Gray	2n=14 II	H. Lewis, LA	*Lewis* in 1955, LA	Mather, Tuolumne County, California
CRUCIFERAE				
**Dithyrea californica* Harv.	2n=10 II	H. Lewis, LA	*Lewis* in 1955, LA	Borrego Valley, San Diego County, California
**Erysimum capitatum* var. *bealianum* (Jeps.) Rossbach	2n=16 II	P. Raven, LA	*Mathias 3027*, LA	Kern County, California
**Lyrocarpa palmeri* S. Watson	n=20	P. Raven, LA	*Lewis* in 1957, LA	Sentenac Canyon, San Diego County, California
**Streptanthus inflatus* (S. Watson) Greene	2n=14 II	H. Lewis, LA	*Lewis* in 1957, LA	Temblor Range, Kern County, California
LINACEAE				
**Cathartolinum digynum* (A. Gray) Small	2n=8 II	P. Raven, LA	*Lewis* in 1955, LA	Mather, Tuolumne County, California

(continued on p. 50)

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* Prepared slide available.

[1] Symbols for institutions are those listed by Lanjouw and Stafleu, Index Herbariorum, Part I. Third Edition, 1956, Utrecht.

SPECIES	NUMBER	COUNTED BY	COLLECTION	LOCALITY
APOCYNACEAE				
**Amsonia brevifolia* A. Gray	2n=22	C. Epling, LA	*Lewis* in 1940, LA	Quail Springs, San Bernardino County, California
**Amsonia brevifolia* var. *tomentosa* (Torr. & Frem.) Jepson	2n=22	C. Epling, LA	*Lewis* in 1940, LA	Quail Springs, San Bernardino County, California
BORAGINACEAE				
**Coldenia canescens* DC.	n=9	M. S. Cave UC	*Raven 13122,* UC	Kaibab Trail, so. rim of Grand Canyon, Coconino County, Arizona
**palmeri* A. Gray	n=8	H. F. Chisaki, UC	*Alava 1831,* JEPS	27 miles south of Vidal, Riverside County, California
**plicata* (Torr.) Coville	n=8	H. F. Chisaki, UC	*Alava 1809,* JEPS	Junction of highways 80–98 and road from Ogilby, Imperial County, California
**purpusii* Brandegee	n=9	H. F. Chisaki, UC	*Moran 6320,* UC	South of José María Aguirre, Nuevo Leon, Mexico
**Cryptantha pterocarya* (Torr.) Greene	n=12	H. F. Chisaki, UC	*Raven 11723,* UC	Gila Mountains, Yuma County, Arizona
**Heliotropium parviflorum* L.	n=13	H. F. Chisaki, UC	*Chisaki 1168,* UC	San Blas, Nayarit, Mexico
**Myosotis versicolor* (Pers.) Smith	n=12	H. F. Chisaki, UC	*Alava 2295,* UC	Pitkin Marsh, Sonoma County, California
VERBENACEAE				
Glandularia perackii Covas et Schnack	n=5	O. T. Solbrig, UC	*Solbrig 2839,* UC	Sierra de San Luis, San Luis Province, Argentina (grown at the U.C. Bot. Garden, Berkeley, Calif.)
gooddingii (Briq.) O. T. Solbrig[2]	n=10	O. T. Solbrig, UC	*Solbrig 2803,* UC	Highway 66, 19.8 miles west of Seligman, Arizona

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[2] **Glandularia gooddingii** (Briq.) O. T. Solbrig comb. nov. (*Verbena gooddingii* Briq., Ann. Conserv. & Jard. Bot. Genève 10:103. 1907.)

SPECIES	NUMBER	COUNTED BY	COLLECTION	LOCALITY
andularia canadensis (L.) Small	$n=15$	O. T. Solbrig, UC	*Solbrig 2840,* UC	Cultivated at the U.C. Bot. Garden, Berkeley, Calif.
rbena bracteata Lag. & Rodr.	$n=14$	O. T. Solbrig, UC	*Solbrig 2909,* UC	Highway 20, 12 miles west of Niles, Oregon
prostrata R. Br.	$n=7$	O. T. Solbrig, UC	*Chisaki, Sharsmith & Solbrig 2823,* UC	Hernandez, San Benito Connty, California
LABIATAE				
gastache urticifolia (Benth.) Ktze.	$2n=9_{II}$	H. L. Wedberg, LA	*Lewis* in 1956, LA	Mather, Tuolumne County, California
onardella cinerea Abrams	$2n=21_{II}$	P. Raven, LA	*Raven 11197,* CAS	San Gabriel Mountains, Los Angeles County, California
onardella lanceolata Bentham	$2n=21_{II}$	H. Lewis, LA	*Lewis* in 1955, LA	Mather, Tuolumne County, California
onardella linoides A. Gray	$2n=21_{II}$	H. L. Wedberg, LA	*Raven 9327,* LA	Piute Mountains, Kern County, California
SOLANACEAE				
hamaesaracha nana A. Gray	$2n=12_{II}$	P. Raven, LA	*Lewis* in 1956, LA	Silver Lake, Mono County, California
olanum xantii A. Gray	$2n=12_{II}$	H. Lewis, LA	*Levene* in 1949, LA	West Los Angeles, Los Angeles County, California
SCROPHULARIACEAE				
rthocarpus attenuatus A. Gray	$2n=12_{II}$	H. Lewis, LA	*Lewis* in 1956, LA	Near Arvin, Kern County, California
rthocarpus linearilobus Benth.	$n=24$	H. Lewis, LA	*Lewis* in 1956, LA	Near Arvin, Kern County, California
rthocarpus purpurascens A. Gray	$2n=12_{II}$	H. Lewis, LA	*Lewis* in 1956, LA	Near Arvin, Kern County, California

(continued on p. 52)

SPECIES	NUMBER	COUNTED BY	COLLECTION	LOCALITY
CUCURBITACEAE				
**Marah macrocarpus* (Greene) Greene	$2n=32_{II}$	H. Lewis, LA	*Lewis* in 1950, LA	Santa Monica Mountains, Los Angeles County, California
COMPOSITAE				
**Chaenactis Douglasii* var. *rubricaulis* (Stockwell) Ferris	$n=6$	R. O. Alava, UC	*Bacigalupi & Alava 6497*, JEPS	Converse Mountain Fresno County, California
**Chrysopsis foliosa* Nutt.	$n=18$	R. C. Jackson, KANU	*Jackson 2464*, KANU	Sandoval County, New Mexico
Haplopappus ciliatus (Nutt.) DC.	$2n=12$	R. C. Jackson, KANU	*Richards 2648*, KANU	Barber County, Kansas
**Haplopappus divaricatus* (Nutt.) Gray	$2n=10$	R. C. Jackson, KANU	*Richards 2055*, KANU	Barber County, Kansas
**Haplopappus hartwegii* (Gray) Blake	$n=6$	R. C. Jackson, KANU	*Jackson 2465*, KANU	San Juan County, New Mexico
**Haplopappus pleuriflorus* (Gray) Hall	$n=12$	R. C. Jackson, KANU	*Jackson 2507*, KANU	Rio Arriba County, New Mexico
**Machaeranthera gymnocephala* (DC.) Shinners	$n=5$	R. C. Jackson, KANU	*Jackson 2516 -1*, KANU	Otero County, New Mexico
Machaeranthera tanacetifolia (H.B.K.) Nees	$n=4$	R. C. Jackson, KANU	*Jackson 2556*, KANU	Socorro County, New Mexico
**Ratibida tagetes* (James) Barnhart	$n=16$	R. C. Jackson, KANU	*Jackson 2565*, KANU	Bernalillo County, New Mexico
**Ratibida columnaris* (Pursh) Raf.	$n=14$	R. C. Jackson, KANU	*Jackson 2133*, KANU	Otero County, New Mexico
**Ratibida peduncularis* var. *picta* Gray	$n=14$	R. C. Jackson, KANU	*Richards 564*, KANU	Wilson County, Texas
**Senecio longilobus* Benth.	$n=20$	R. C. Jackson, KANU	*Jackson 2037*, UNM	Bernalillo County, New Mexico
Zinnia grandiflora Nutt.	$n=24$	R. C. Jackson, KANU	*Jackson 2002*, UNM	Bernalillo County, New Mexico

TYPIFICATION OF PROSOPIS ODORATA TORR. & FREM. (LEGUMINOSAE)

Lyman Benson

Clarification of the concept of *nomina ambigua* and *nomina confusa* in the 1956 edition of the International Code of Botanical Nomenclature makes unnecessary my proposal (1941) that *Prosopis odorata* be included in the list of *Nomina confusa*. Article 66 (Lanjouw, et al., 1956) declares *nomina ambigua* to be illegitimate unless a satisfactory separation of the ambiguous elements can be made. If separation can be made clearly, one constituent must be designated as a lectotype. With this in mind, re-examination of the nomenclatural status of *Prosopis odorata* Torr. & Frem. (in Frem. 2nd. Rept. Expl. Exped. Rocky Mts., Ore., Calif. 313, pl. 1, 1845) is in order.

Three specimen sheets of the Fremont collection upon which *Prosopis odorata* is based are in the Torrey Herbarium, New York Botanical Garden. On each sheet there is a fallen fruiting spike with a cluster of fruits from the screw-bean, *Prosopis pubescens* Benth. The bulk of the material on each sheet consists of vegetative branches with spines, young leaves, and spikes of flowers of the western honey mesquite, *Prosopis juliflora* (Swartz) DC. var. *Torreyana* L. Benson. This mixture of material from two species resulted from collection of specimens in April when the mesquite was developing new leaves and was in flower. Probably the peculiar spiral pods were added from the ground. The two species often grow together along washes or in springy areas, and confusion may have arisen either in collecting specimens or in sorting them. The ambiguity of the type specimen of *Prosopis odorata* has been discussed as follows (Benson, 1941, pp. 753–754):

> "Type collections: (1.) *P. odorata,* 'A characteristic tree in the mountainous part of northern [Alta] California, particularly along the Mohave [Mojave] and Virgen rivers [Virgin River in Nevada, Arizona, and Utah] the latter part of April.' According to Torrey, Pac. R.R. Rept. 4:82. 1855, the plant 'is *P. glandulosa* (in flower only), with the pods of *Strombocarpa pubescens.* The error arose from the mixing of specimens in Fremont's collections.' Torrey appended the following note to one of the three type sheets now in the New York Botanical Garden, 'I have scarcely a doubt that the leaves belong to *P.* (*Algarobia*) *glandulosa*—the fruit to *Stromb. pubescens*! I was led astray by Fremont placing the pods and the leafy specimens together—.' Interpretations of *P. odorata* have varied. Standley, Contr. U. S. Nat. Herb. 23: 353. 1922, in discussing the nomenclature of *P. juliflora* var. *velutina,* argued as follows: 'In case the plant should receive such recognition [as a species instead of a variety], the proper name for it is *Prosopis odorata* Torr. That name was based upon a flowering specimen of the present plant and fruit of *P. pubescens,* and for that reason has been discarded by most writers. Taking into consideration the specific name, 'odorata,' it seems reasonable to typify the name by the flowering specimen.' The branches with leaves and young flowers included in the type of *P. odorata* are neither *P. glandulosa* (*i.e., P. juliflora* var. *glandulosa*) as supposed by Torrey nor, despite the presence of a few hairs on the rachilla and secondary leaflets, *P. juliflora* var. *velutina* as supposed by Standley. Instead, they are *P. juliflora* var. *Torreyana.* Britton and Rose, N. Amer. Fl. 23: 183. 1928, took up the specific epithet *odorata* under *Strombocarpa* for the screw-bean. According to Article 64 of the In-

ternational Rules of Botanical Nomenclature, 'A name of a taxonomic group must be rejected if the characters of that group were derived from two or more entirely discordant elements, especially if those elements were erroneously supposed to form part of the same individual. A list of names to be abandoned for this reason (*Nomina confusa*) will form Appendix V' [not published]. The writer proposes that *Prosopis odorata* Torr. should be included in this list."

In the light of the 1956 rule, it is fortunate that in this instance segregation is clear and unmistakable, and the choice is easy. *Prosopis pubescens* Benth. (in Hook. Lond. Jour. Bot: 5:82. 1846) is established clearly in nearly all recent literature for the screw-bean, and changing the name by substituting *Prosopis odorata,* published one year earlier, is not desirable, even though this was done by Britton and Rose (loc. cit.). Furthermore, selection of the fruits alone for a lectotype would be less satisfactory than choice of the combination of twigs, leaves, and flowers. So long as *Prosopis juliflora* var. *Torreyana* is considered to be a variety, restriction of the type specimen of *Prosopis odorata* to include only the material from that population system will cause no nomenclatural upset. Therefore, the three sheets in the Torrey Herbarium of the New York Botanical Garden, the fruits excluded, are designated together as a lectotype of *Prosopis odorata* Torr. & Frem.

If the lectotype rule had been adopted before 1941, the writer would have recombined the epithet *odorata* in varietal rank under *Prosopis juliflora* (Swartz) DC. rather than to add the new epithet var. *Torreyana* to the nomenclature. Should var. *Torreyana* be elevated to specific rank, however, it must be known as *Prosopis odorata* Torr. & Frem.

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TWO NEW SPECIES OF HELIANTHUS FROM NEW MEXICO[1]

R. C. JACKSON

During a field study of the New Mexican species of *Helianthus,* two new species were discovered. Morphologically they appear to be related to *Helianthus ciliaris* DC. but differ from this species in several diagnostic characteristics.

Helianthus heiseri sp. nov. Herba perennis 5–12 dm. alta; caulibus pluribus (vel unica) sparse strigosis, flavo-viridibus, striatis; foliis oppo-

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[1] Field work for this study was supported by faculty research grants from the University of New Mexico.

sitis, sessilibus; laminis ad 7 cm. longis 2.3 cm. latis, cuneatis vel obtusis, acuminatis, serratis vel dentato-crenatis, ambis paginis strigosis resinosisque, nervis tribus conspicuis instructis; capitulis 1–3 in pedunculis 4–10 cm. longis; disco diam. 1.5–2.0 cm.; phyllariis lanceolatis, ciliatis, dorso levibus viridibusque, 2.6–3 mm. latis, 8–10 m. longis; radiis 16–20, 10–12 mm. longis; disci corollis 4–4.5 longis, basi flavis puberulentisque, lobis purpureis puberulentisque; receptaculi paleis acutis purpureis disci corollas aequantibus, earum apicibus acutis dorso plus minusve villosis; achaeniis ca. 3 mm. longis in maturitate nigris; pappis florium discorum aristis 2 lanceolatis instructis; pappis eorum radiorum aristis 1–3 inaequalibus lanceolatis item instructis.

Perennial herb, 5–12 dm. high; stems one or several, sparingly strigose, yellowish-green, striate; leaves opposite, sessile, the blades up to 7 cm. long and 2.3 cm. wide, cuneate or obtuse at the base, acuminate at the tip, serrate or dentate-crenate on the margins, strigose and resin-dotted above and below, conspicuously 3-nerved; heads 1–3 on peduncles 4–10 cm. long; disc 1.5–2.0 cm. in diameter; phyllaries lanceolate, ciliate, smooth and green on the backs, 2.6–3.3 mm. wide, 8–10 mm. long; rays 16–20, 10–12 mm. long; disc corollas 4–4.5 mm. long, yellow and puberulent at the base, the lobes purple and puberulent; pales of the receptacle acute, purple, about equal with the disc corollas, the tips moderately villous on the backs; achenes about 3 mm. long, black at maturity; pappus of the disc of 2 lanceolate awns, the pappus of the rays of 1–3 unequal, lanceolate awns.

Type. New Mexico. Grant County: shallow ditch near the Mimbres River, elevation ca. 5400 feet, September 30, 1957, *Jackson 2521–1* (IND.) Isotype. *Jackson 2521–2* (UNM).

Additional specimens from the type locality are deposited in the herbaria listed above.

Thus far *H. heiseri* is known only from the Mimbres River Valley where it has been observed at several sites other than the type locality. This entity was probably responsible for Torrey's (1859) report of *H. grosseserratus* in "the valley of the Mimbres." The two species have several characteristics in common.

Helianthus crenatus sp. nov. Herba perennis 5–12 dm. alta; caulibus pluribus (vel unica), sparse strigosis, flavo-viridibus, striatis; foliis oppositis, sessilibus vel brevipetiolatis; laminis ad 9 cm. longis et 2.3 cm. latis, oblanceolatis, acutis, attenuatis, inaequaliter crenatis vel crenato-lobatis insuper strigosis resinosisque, subtus strigosis vel strigoso-pilosis resinosisque, nervis tribus conspicuis instructis; capitulis 1–6 in pedunculis 6–13 cm. longis; disco diam. 1.8–2.4 cm.; phyllariis anguste lanceolatis, ciliatis, dorso in maturitate strigosis, aliquantulum patentibus, 2 3 mm. latis, 10–12 mm. longis; radiis 16–20, 10–12 mm. longis; disci corollis 5–5.7 mm. longis, basi flavis puberulentisque, lobis purpureis puberulentisque; receptaculi paleis quam disci corollis brevioribus, purpureis, dorso ad apicem versus moderate villosis; achaeniis ca. 3 mm. longis, in maturitate nigris; pappis florium discorum aristis 2 lanceolatis instructis; pappis eorum radiorum aristis 1–3 inaequalibus lanceolatis item instructis.

Perennial herb, 5–12 dm. high; stems one or several, sparingly strigose, yellowish-green, striate; leaves opposite, sessile or short petioled, the blades up to 9 cm. long and 2.3 cm. wide, oblanceolate, acute, attenuate at the base, unequally crenate or crenate-lobed on the margins, strigose and resin-dotted above, strigose or strigose-pilose and resin-dotted below; conspicuously 3-nerved; heads 1–6 on peduncles 6–13 cm. long; disc 1.8–2.4 cm. in diameter; phyllaries narrowly lanceolate, ciliate, strigose on the backs, somewhat spreading at maturity, 2–3 mm. wide, 10–12 mm. long; rays 16–20, 10–12 mm. long; disc corollas 5–5.7 mm. long, the base yellow and puberulent, the lobes purple and puberulent; pales of the receptacle shorter than the disc corollas, purple, acute, the tips moderately villous on the backs toward the apices; achenes about 3 mm. long, black at maturity; pappus of the disc of 2 lanceolate awns; the pappus of the rays of 1–3 uneven lanceolate awns.

Type. New Mexico. Sierra County: low area on the south side of Truth or Consequences, June 22, 1957, *Jackson 2504–1* (IND). Isotype. *Jackson 2504–2* (UNM).

Additional specimens are deposited in the herbaria listed above.

Helianthus heiseri and *H. crenatus* are closely related morphologically. The main diagnostic differences separating the two are apparent in the descriptions. In addition, the two species are separated by flowering dates. *Helianthus crenatus* reaches its maximum flowering period during the latter part of July, whereas *H. heiseri* reaches its peak from the middle to the latter part of September. Geographically the two species are separated by the Black Mountain Range.

It is quite possible that *H. crenatus* and *H. heiseri* may have been lumped with *H. ciliaris* DC. in the past. Some of the distinguishing characteristics are listed below in a comparison of the two new species with *H. ciliaris* as it occurs in the Rio Grande Valley of New Mexico.

	H. ciliaris	*H. heiseri*	*H. crenatus*
Stems	Mostly glabrous, glaucous	Sparingly strigose	Sparingly strigose
Leaves	Glabrous, bluish-green and glaucous	Strigose, light- or yellowish-green, resin-dotted	Strigose to strigose-pilose, light- or yellowish-green, resin-dotted
Phyllaries	Ovate, obtuse, erect appressed, glabrous or subglabrous on the back, ciliate, about 3.5 mm. wide, 5–7 mm. long	Lanceolate, acute, loose, glabrous on the back, ciliate, 2.6–3.3 mm. wide, 8–10 mm. long	Narrowly lanceolate somewhat spreading, strigose on the back, ciliate, 2–3 mm. wide, 10–12 mm. long

In the population of *H. crenatus,* several individuals not typical of the population as a whole were found. These plants were different from the type in that some had long trichomes on the stem, the leaves were ashy grey, more heavily pubescent, and they apparently flowered earlier. Hybridization between *H. crenatus* and *H. ciliaris* may have been responsible for some of these variations, but generally they represent combinations not present in either species. Furthermore, Heiser and Smith (1955) have reported the chromosome number of *H. ciliaris* as n=51 (also n=34, Heiser unpublished) while the writer has found n=17 in *H. crenatus*. It may well be that these variations resulted from past hybridization with an unknown or now extinct species.

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CHROMOSOME COUNTS IN THE SECTION SIMIOLUS OF THE GENUS MIMULUS (SCROPHULARIACEAE). III.

Barid B. Mukherjee and R. K. Vickery, Jr.

This report[1] on the determination of chromosome numbers in the section *Simiolus* of the genus *Mimulus* is an integral part of a long range investigation into the taxonomy, genetics, and evolution of species in *Mimulus* (Vickery, 1951). Taken in conjunction with the previous counts (Vickery, 1955 and Mukherjee, Wiens, and Vickery, 1957), the counts reported here reveal a pattern of evolution in section *Simiolus* that involves both polyploidy and aneuploidy.

A slightly modified version of the technical method of Swaminathan, Magoon, and Mehra (1954) was found to produce better results than the methods previously used (Vickery, 1955 and Mukherjee, Wiens, and Vickery, 1957). Buds expected to contain anthers at the desired stages of microsporogenesis were killed and fixed for 24 hours in a mixture of two parts absolute ethanol and one part glacial acetic acid saturated with ferric acetate. Acetic acid was substituted for the propionic acid called for in Swaminathan, Magoon, and Mehra's schedule. Also, the buds were transferred after 24 hours to 70 per cent ethanol whereas their schedule called for leaving the buds in the fixative until used. The anthers were dissected out of the buds, smeared and stained in iron-aceto-carmine. Camera lucida drawings were made for each count and, in addition, photomicrographs were taken of the more intricate configurations. Each chromosome number reported is based on counts from an average of approximately ten microsporocytes. Herbarium specimens were prepared for each of the cultures studied. They will be deposited for future reference in the Garrett Herbarium of the University of Utah.

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[1] This work was supported by the National Science Foundation. It forms a portion of the dissertation of the senior author submitted to the faculty of the University of Utah in partial fulfillment of the requirements of the Ph.D. degree. The authors wish to thank Drs. W. W. Newby and C. M. Woolf for their helpful criticisms of the manuscript.

A total of eleven cultures was studied during the present investigation (table 1). The cultures include representatives of seven species and varieties of the section *Simiolus*: *M. guttatus* DC., *M. tilingii* Regel var. *tilingii*, *M. tilingii* var. *corallinus* (Greene) Grant, *M. glaucescens* Greene, *M. glabratus* var. *parviflorus* (Lindl.) Grant, *M. pilosiusculus* HBK., and *M. tigrinus* hort.

Of the five cultures of *M. guttatus* examined, three, (5003, 5007, and 5839) showed $n=14$ chromosomes. The configurations were regular and similar to those observed previously for other cultures of *M. guttatus* (Vickery, 1955, Mukherjee, Wiens, and Vickery, 1957). However, the two cultures of *M. guttatus* from Mather, California, exhibited frequent lagging chromosomes during the anaphase stage of the first meiotic division. Eight cells from three different plants of culture 5009 were observed at this stage of division. Two pairs of lagging chromosomes were found in each of two cells, one pair in each of three cells and no lagging chromosomes in the remaining three cells. In addition, two cells from two different plants of the other Mather culture, 5010, were observed at the first anaphase stage of meiosis. These cells each contained a single pair of lagging chromosomes. The cause of the lagging chromosomes was not clear from the configurations studied. Observations of five cells in the first telophase stage of division revealed that in one case the lagging pair of chromosomes was not being included in either nucleus whereas in the other four cases, both members of the pair were being included in one nucleus producing 15 to 13 segregations of the chromosomes. Observations of cells in the second metaphase stage of division confirmed the reality of these irregular segregations and indicated that, apparently, in a few cases, two pairs of lagging chromosomes had been included in the same daughter nucleus. Of such 16 to 12 segregations, only cells with 16 chromosomes were actually observed. Perhaps the number of cells studied was too small a sample to detect cells with 12 chromosomes which may be less viable than cells with 13 or more chromosomes. Of the 22 configurations of second metaphase chromosomes observed in microsporocytes of three plants of culture 5009, three contained 14 chromosomes, twelve contained 15, five contained 13, and two contained 16. Of twelve configurations of second metaphase chromosomes observed in microsporocytes of plants of culture 5010 five contained the normal number of 14 chromosomes, four

Table 1. Chromosome Counts in Mimulus, Section Simiolus

n = 14	*M. guttatus* DC. Pescadero, San Mateo County, California, altitude 20 feet, *Clausen 2083* (5003). Yosemite Junction (marsh), Tuolumne County, California, altitude 1,350 feet, *Hiesey 559* (5007). Big Cottonwood Canyon, Salt Lake County, Utah, altitude 7,100 feet, *Vickery 334* (5839).
	M. glaucescens Greene Richardson Springs, Butte County, California, altitude 600 feet, *F. W. Pennell & A. A. Heller 25667* (5653).
n = 14 ± 1 or 2	*M. guttatus* DC. Mather (meadow), Tuolumne County, California, altitude 4,600 feet, *Hiesey 571* (5009). Mather (spring area), Tuolumne County, California, altitude 4,800 feet, *Hiesey 569* (5010).
n = 15	*M. tilingii* Regel *tilingii* Mount Timpanogos, Utah County, Utah, elevation 7,800 feet, *Del Wiens,* Aug. 6, 1956 (5967).
n = 24	*M. tilingii* var. *corallinus* (Greene) Grant Porcupine Flat, Mariposa County, California, altitude 8,000 feet, *Hiesey 576* (5011).
n = 32	*M. tigrinus* hort. Commercial seeds from F. Kirchhoff and Co., Johannesburg, South Africa (5056).
n = 45	*M. glabratus* var. *parviflorus* (Lindl.) Grant Illapel, Coquimbo, Chile, altitude 4,000 feet; Plant Introduction Service no. 144534, USDA (5041).
n = 46	*M. pilosiusculus* HBK. Botanic Garden, Copenhagen, Denmark (wild in Argentina, Chile, and Peru); Plant Introduction Service no. 181130, USDA (5320).

contained 15, one contained 13 and two contained 16. Thus, in the Mather cultures irregular meioses occurred in more than 50 per cent of the microsporocytes and a comparable proportion of aneuploid microspores was produced. If the resulting aneuploid gametes are functional, even occasionally, they might lead to the formation of aneuploid plants or populations. If such gametes are generally non-functional, they might help to explain the marked self and cross sterility observed in the Mather cultures in comparison to the relatively high self and cross fertility of other cultures of *M. guttatus* (Vickery, in press).

Mimulus glaucescens (5653) is morphologically closely related to *M. guttatus* (Pennell, 1951). It has n=14 chromosomes which are indistinguishable in appearance from those of *M. guttatus* (fig. 1). This investigation revealed no cytological basis for the strong crossing barrier (Vickery, 1956) that separates *M. glaucescens* from *M. guttatus* and its related species.

Mimulus tilingii var. *tilingii* (culture 5967) from a population growing on Mount Timpanogos of the Wasatch Mountains, Utah, generally has n=15 chromosomes in contrast to other Utah and California populations

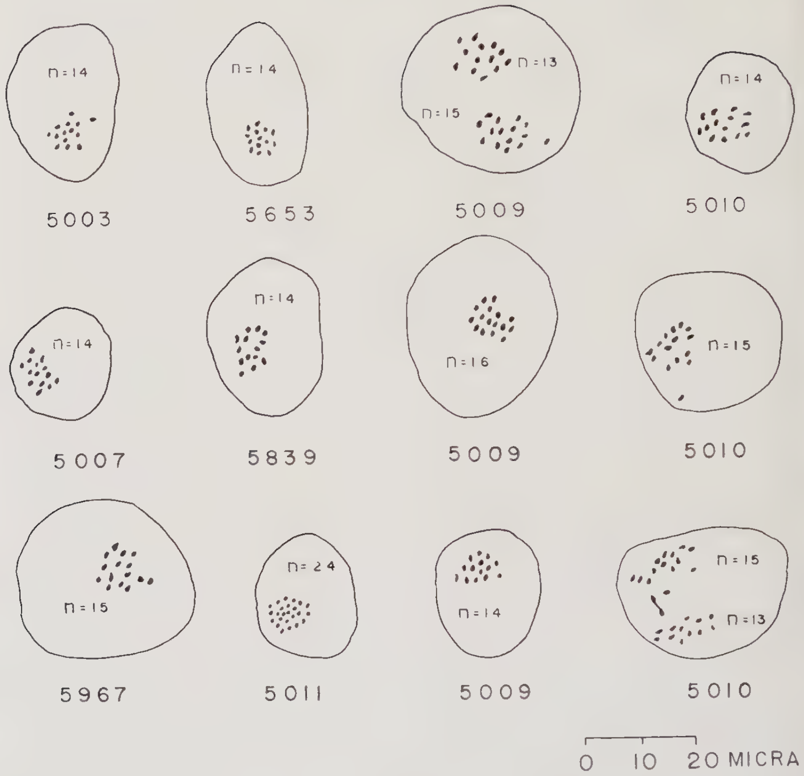

FIG. 1. Meiotic chromosomes of North American *Mimulus: M. guttatus,* 5003, 5007, 5009, 5010, 5839; *M. glaucescens,* 5653; *M. tilingii* var. *tilingii,* 5967, var. *corallinus,* 5011. All cells are in or near second metaphase except 5007, 5011, and 5967 which are in first metaphase. (Camera lucida drawings, × 645.)

of that variety which have n=14 (Vickery, 1955 and unpublished). Various stages of meioses were examined in 16 microsporocytes from three different plants of culture 5967. Two of the cells contained 13 and 14 chromomoses instead of the more prevalent 15. However, *M. tilingii* var. *tilingii* did not show irregular numbers nearly as frequently as did the Mather populations of *M. guttatus.*

Mimulus tilingii var. *corallinus* (culture 5011) is closely related morphologically to *M. guttatus* and to *M. tilingii* var. *tilingii* (Grant, 1924) but is effectively separated from them by genetic barriers (Vickery, 1956). Culture 5011 forms sterile hybrids with *M. guttatus* and will not hybridize, despite numerous attempts, with *M. tilingii* var. *tilingii. Mimulus tilingii* var. *corallinus* has n=24 chromosomes in contrast to the n=14 of *M. guttatus* and the n=14 and n=15 of *M. tilingii* var. *tilingii.* Further work is in progress to try to establish the chromosome homologies

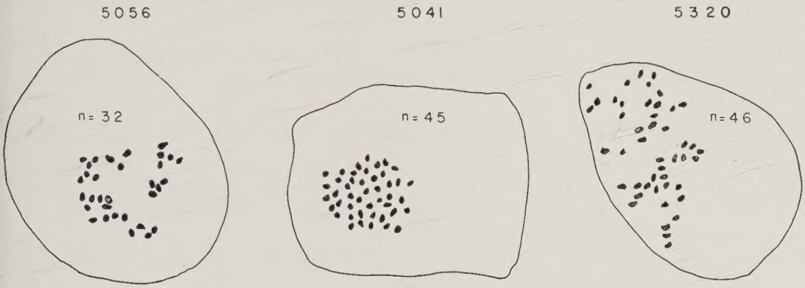

FIG. 2. Meiotic chromosomes of South American *Mimulus: M. tigrinus,* 5056 (first metaphase); *M. glabratus* var. *parviflorus,* 5041 (second metaphase); *M. pilosiusculus,* 5320 (second metaphase). (Camera lucida drawings, × 1134.)

and the genetic relationships of the various entities within the *Mimulus tilingii* complex.

The three species from South America used in this study have higher chromosome numbers than any of the North American forms determined thus far. *Mimulus glabratus* var. *parviflorus* (culture 5041) from the Andes Mountains of Chile has n=45 chromosomes and *M. pilosiusculus* (culture 5320), originally from southern South America, has n=46 (fig. 2). *Mimulus tigrinus* hort., a cultivated derivative of *M. luteus* L. (Miller and Bailey, 1947) has n=32 chromosomes (fig. 2) which agrees with the report of Brozek (1932).

In conclusion, this survey of chromosome numbers and behavior in section *Simiolus* indicates that in general the chromosome number for *M. guttatus* is n=14. However, aneuploid microspores are produced with a frequency of greater than 50 per cent in the two cultures of *M. guttatus* from Mather. Such microspores, if functional even occasionally, might lead to the production of aneuploid plants or populations of *M. guttatus* similar to the aneuploid populations found in *M. tilingii* var. *tilingii, M. glabratus* var. *utahensis* and in the *M. glabratus* var. *parviflorus*—*M. pilosiusculus* group. The high chromosome numbers found in the South American species indicate that polyploidy, as well as aneuploidy, plays an important role in the evolution of species in section *Simiolus*. Further work is in progress to elucidate the questions of the cytogenetic relationships and taxonomic status of several entities in section *Simiolus* which have been raised by the results of this investigation.

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REVIEW

Pollen and Spore Morphology/Plant Taxonomy. Gymnospermae, Pteridophyta, Bryophyta (Illustrations). (An Introduction to Palynology. II). By Gunnar Erdtman. 151 pp., frontispiece, 5 plates, 265 figs. Almquist & Wilsell, Stockholm. 1957. $8.00.

Over a period of more than 13 years, Gunnar Erdtman has undertaken the voluminous task of describing and illustrating representative pollen and spores of the world's plants. His contribution toward better understanding of the fundamentals of microspore morphology has given world-wide impetus to the development of this aspect of plant morphology and to palynology.

Erdtman's earlier publications were largely concerned with the pollen morphology of the more common angiosperms and gymnosperms in the experience of the Pleistocene pollen-analyst. Pollen workers, 10–15 years ago, were generally satisfied with knowing the gross morphologic features and key characteristics of pollen of the common wind-pollinated genera. Within the past few years, however, the boundaries of pollen work have been vastly expanded. The need for a thorough understanding of the pollen morphology of living plants has become increasingly apparent in identification and interpretation of fossil pollen, as well as a basis for the application of pollen morphology to systematic studies. Need for clarification of many of the details of microspore morphology and knowledge of pollen and spores of increasing numbers of plants has been answered in part by two volumes recently published by Erdtman. "An Introduction to Palynology. I. Pollen Morphology and Plant Taxonomy. Angiosperms" appeared in 1952. The volume being reviewed, "An Introduction to Palynology. II.", comprises the illustrations to the text of a treatise (Vol. III) on the morphology of microspores of the gymnosperms, pteridophytes and bryophytes which will be published at a later date.

Volume II includes "palynograms" (diagrammatic drawings showing the gross morphology of the grains as well as details of the surface pattern and exine stratification), a few photomicrographs and some electron micrographs of thin sections through spore walls of representatives of 12 gymnosperm families, 29 pteridophytic and 63 bryophytic families (23 Hepaticae and 40 Musci). Also included are similar illustrations for the surface pattern of, and optical sections through, the megaspore membrane of a few members of the Cupressaceae, Pinaceae and Podocarpaceae among the gymnosperms and the Isoetaceae, Pilulariaceae and Selaginellaceae among the pteridophytes. The illustrations are arranged in sections dealing with each of the major groups: Gymnospermae, Pteridophyta and Bryophtya. Within each section the figures are placed alphabetically by genus. Reference to the family to which each genus belongs is made only at the beginning of the section. Spore palynograms of the Hepaticae and Musci are ordered alphabetically without regard to their class within the Bryophyta. This treatment makes for much clumsiness in use of the book by other than one well informed with the taxonomy of each group, and is the most serious fault one may find with this publication. Part of the difficulty could have been overcome by cross-referencing all genera to family. An arrangement in conformity with an acceptable taxonomic heirarchy would have been far more satisfactory, however, in gaining understanding of the overall microspore morphology of a family in terms of the representatives illustrated, or in attempting to compare the spore morphology of related families. One other less serious criticism which might be leveled at this publication is that concerning the number of figures and plates (3 out of 5) which have appeared already in other publications which most palynologists and others interested in microspore morphology would have seen. Some 17 figures and plates, in large part, or the only illustrations for *Abies, Cedrus, Ephedra, Keteleeria, Picea, Pinus, Pseudolarix, Lycopodium, Ophioglossum,* members of the Hedwigiaceae, Schizaeaceae and Marattiales, have already appeared in one or both of two periodicals in 1954 and 1956: the *Svensk Botanisk Tidskrift* and *Grana Palynologica.* We might suggest that this material could have been supplemented by additional data for these genera or groups in the present publication which purports to be a survey of a large group of plants. While not serious, numerous other obvious errors impair slightly the usefulness of this publication. There is no reference to illustrations of members of the Podocarpaceae (Gymnospermae) other than to one figure of the megaspore membrane of *Dacrydium cupressinum.* Microspores of six podocarpaceous genera are figured. Family references have also been omitted from the lists prefacing sections on Pteridophyta and Bryophyta for *Negripteris incana* (fig. 148, p. 81); *Oleandra neriiformis* (fig. 150, p. 81); *Athalamia nana* (fig. 196, p. 101); *Brachiolejeunia sandwicensis* (fig. 198, p. 102); and *Southbya stillicidiorum* (fig. 245, p. 121). Other errors include absence of page numbers for some figures, or mistakes in page numbers for figures and plates.

A brief Introduction discusses exine morphology and the nature of the bladder among the winged (or saccate) gymnosperms (members of the Pinaceae and Podocarpaceae). Some of the terminology used was introduced and defined in the earlier, 1952, publication. Other terms (mesosaccia, aposaccia, cristae marginales, etc.) are apparently newly introduced further to confuse the already over-termed pollen morphologist. A twenty-two page supplement, containing technical articles by B. M. Afzelius and J. Radwan Praglowski on electron microscopy and cutting ultra-thin sections as an aid to study of exine stratification, completes this publication. Praglowski's article is simply and well presented and well illustrated, and is very welcome to those desiring to undertake the sectioning of pollen grain exines.

It is unfortunate that Vol. II has been published without the proposed accompanying text. The appearance of Vol. III, hopefully in the near future, will be awaited with interest.—JANE GRAY, Geochronology Laboratories, University of Arizona, Tucson.

NOTES AND NEWS

THE OCCURRENCE OF PILOSTYLES THURBERI (RAFFLESIACEAE) IN CALIFORNIA. In various articles and manuals relating to the vegetation of Arizona and California the suggestion has been made that *Pilostyles thurberi* Gray may occur in the desert areas of southern California. Never, as far as I am aware, has a documentation of this range extension been published. The plant, parasitic on the branches of *Dalea emoryi* Gray, seems to be an exceedingly elusive one, as it is rarely collected. Only the minute flowers erupt from the host bark, the vegetative body being completely internal.

It is therefore worthwhile to confirm its occurrence in California. The following specimens, all from the Colorado Desert region of California, leave no doubt as to the presence of the parasite in the state: *Goodding 43–19*, 57 miles south of Indio (UC 690661), *Goodding*, 50 miles south of Indio (UCLA), *Wilson*, 30 miles west of El Centro (POM 273347), *Wilson*, near Ocotillo (RSA 43067). All these collections were on *Dalea emoryi*. On a field trip in 1958 I was unable to locate the parasite in any of the California localities. Because of agricultural developments it may not have survived in some of its known California and Arizona sites (perhaps including the type locality in Yuma County, Arizona). It still exists at Wellton, Yuma County, where it grows along the highway (*Kuijt 1490*, UC).

Pilostyles thurberi is the only species of the Rafflesiaceae in California. The other species of *Pilostyles* show an extraordinary geographical distribution. Some are found in Texas and northern Mexico, others in Chile, in Iraq, in Ethiopia, or in southwest Australia. The hosts are invariably leguminous shrubs growing in desert areas.—JOB KUIJT, Department of Botany, University of California, Berkeley.

NOTES ON THE FLORA OF ARIZONA.—Four interesting collections have come to the herbarium of the University of Arizona for identification during the past year. Of these two are genera new to the state, and two represent second collections of species rare in Arizona. Only one is a foreign weed.

Echinodorus berteroi (Spreng.) Fassett (Alismaceae) was collected 1½ miles north of Imperial Dam in the Imperial National Wildlife Refuge, Yuma County, by Gale Monson. It is a new generic record for Arizona, but one that might be expected. *Echinodorus berteroi* ranges from southern California eastward to the West Indies, but, according to Fassett's citation of specimens (Fassett, N. C. 1955. Echinodorus in the American Tropics. Rhodora 57:133–212), this is the first collection from the Colorado River as well as the first from Arizona.

Cardiospermum halicacabum L. (Sapindaceae), also a genus new to Arizona, was collected by L. N. Goodding and Richard Hevly on a rocky slope in the Coyote Mountains, Pima County. This new locality is about 50 miles north of the International Boundary, while the closest previous collection represented in the University of Arizona Herbarium is near Hermosillo, Sonora, Mexico, about 160 miles south of the border. Although *C. halicacabum* is cultivated as the "balloon vine," the rough, rocky area in which this specimen was growing precludes the possibility that it was an escape.

Beckmannia syzigachne (Steud.) Fernald (Gramineae), collected near Alpine, Apache County, was sent to the University of Arizona for identification by C. L. Isaacson, the county agricultural agent. This collection is the second for the state; the first having been made in 1951 by John Merkle at Greenland Lake, Grand Canyon National Park, Coconino County (Merkle, J. 1953. Beckmannia Syzigachne (Steud.) Fernald, New Record for Arizona. Madroño 12:32). The new collection is about 200 air miles southeast of the first.

Bupleurum rotundifolium L. (Umbelliferae) was brought to the herbarium for identification by a resident of Tucson, Pima County. It was growing in an unseeded, unfertilized section of a yard under an established elm tree (*Ulmus* sp.). This, also, is a second collection, the first having been made in Tucson by Toumey in 1892. Undoubtedly the new collection is a re-introduction of this Mediterranean weed, but the seed source is unknown.

Representatives of all of these collections are on file in the Herbarium of the University of Arizona.—CHARLES T. MASON, JR., Department of Botany, University of Arizona, Tucson.